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A CONVENIENT RECORDING SYSTEM FOR A ROBERTS CURRENT METER

by

R. Frassetto, I. Weisman, and R. Andersen

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Columbia University
Hudson Laboratories
Dobbs Ferry, N. Y.

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Roberto Frassetto, Irving Weisman, and Rolf Anderson

(6) A Convenient Recording System for a Roberts Current Meter.

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Introduction

This recording system permits rapid and continuous interpretation of current velocities and their fluctuations in time by an instrument, "in situ", which measures and transmits the data to a laboratory ship, or to shore. (14) TM-52

The system utilizes the time interval between contact closures made by the Roberts meter every so many revolutions of its impeller. These time intervals, the ordinates, are presented versus time, the abscissa, on a chart recorder.

The envelope of the time intervals gives a rapid visual picture of the situation. Long- and short-period variations of the velocity can be seen at a glance, but above all the system permits the immediate recognition of the response of a shipborne meter to the ship's movements, including yaw, roll, and pitch.

The electronics for the system are simple, economical, and obviate the time-consuming data processing heretofore necessary. The recorder can be calibrated in the field by means of a stop watch.

(9) Technical memo.,

(10) Roberto /Frassetto, Irving /Weisman
Rolf /Anderson

Equipment Description

The Roberts Meter:

The well-known Roberts meter was used by the authors because it was available at our laboratory. Its signals can be transmitted either through a cable to a ship or to a buoy, then via radio to a ship or to shore. (11) 15 Aug 60

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Every ten revolutions of the impeller, the mechanism of our ship-borne meter closes (makes and breaks) electrical contacts at the end of two conductors of the suspending double-armored cable (3/10-in outer diameter; tensile strength, 6000 lbs). In addition, another closure is made which is a function of the azimuthal orientation of the Roberts meter. This directional closure occurs once for every two velocity closures. The relative occurrence, in time, of the directional closure with respect to the velocity closures indicates the orientation of the meter, coincidence with the first velocity closure indicating 0 deg, and coincidence with the second velocity closure indicating 360 deg.

An electric swivel connects the meter to the deep end of the cable, at which point a pressure gauge is also connected in order to transmit depth information to a balancing bridge on the ship.

The calibration of the Roberts meter is critical and must be done in a tank. The bearings of the impeller were changed at this laboratory to stainless steel with an electrofilm, with resulting improved performance, especially at low velocities, and increased ruggedness.

Closure Detector and Relay Amplifier:

In order to differentiate between the two contact closures made in the Roberts meter, namely, the velocity closure and the azimuthal closure, an electrical sensing system was incorporated similar to that employed at the Scripps Institution of Oceanography (see Fig. 1). The contact points in the Roberts meter are wired to diodes oppositely polarized, so that alternating voltage from T_1, sent down the connecting cable, is oppositely rectified, depending upon which closure is made. This rectified voltage, sampled at R_1 (only when the series circuit is completed through a contact closure) is fed to the relay amplifier. Negative voltage at R_1, which is associated with the velocity closure, causes the relay amplifier to close the relay, thus shorting the integrating capacitor in the sweep circuit described below. This resets the sweep circuit.

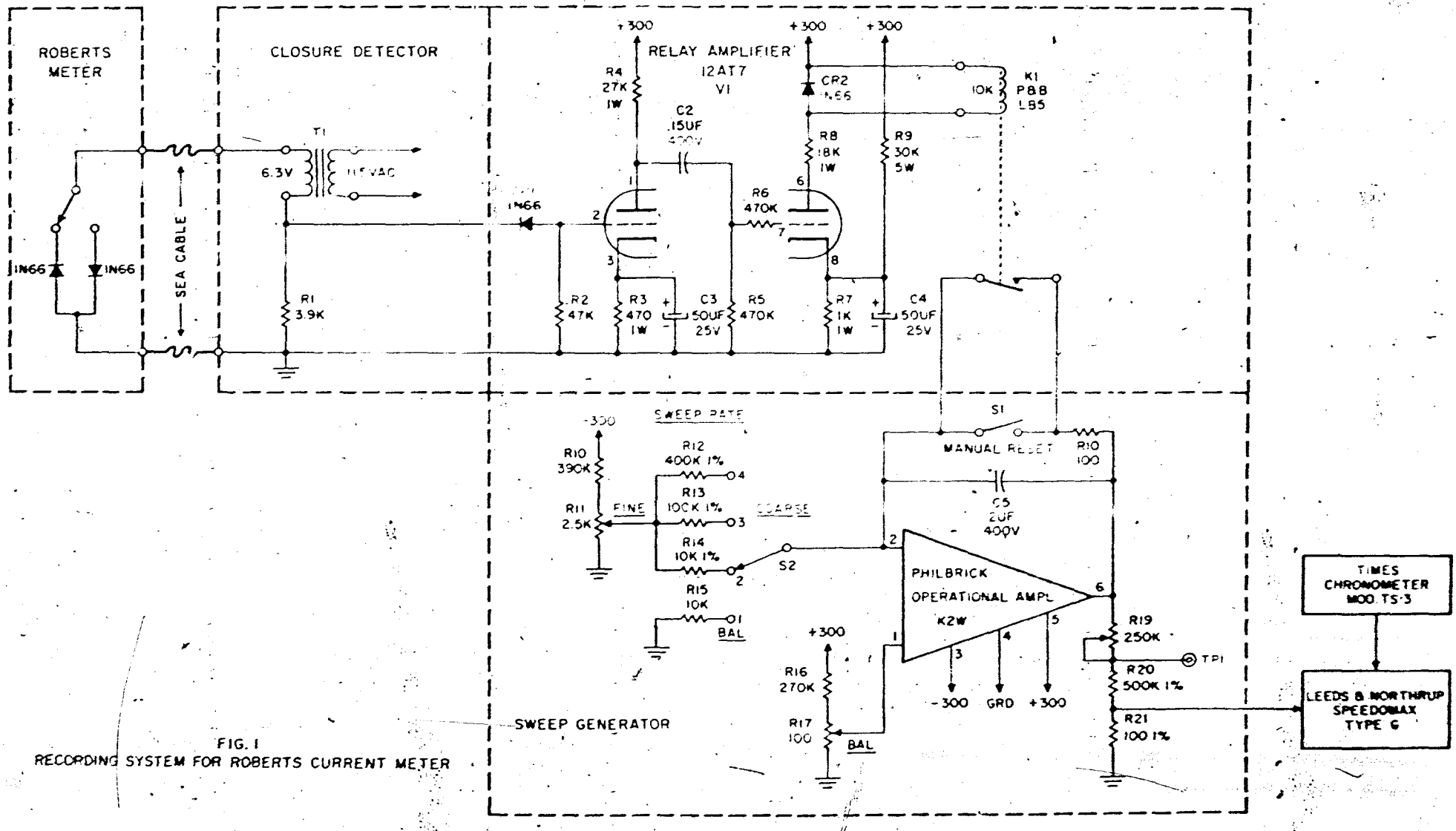


FIG. 1
RECORDING SYSTEM FOR ROBERTS CURRENT METER

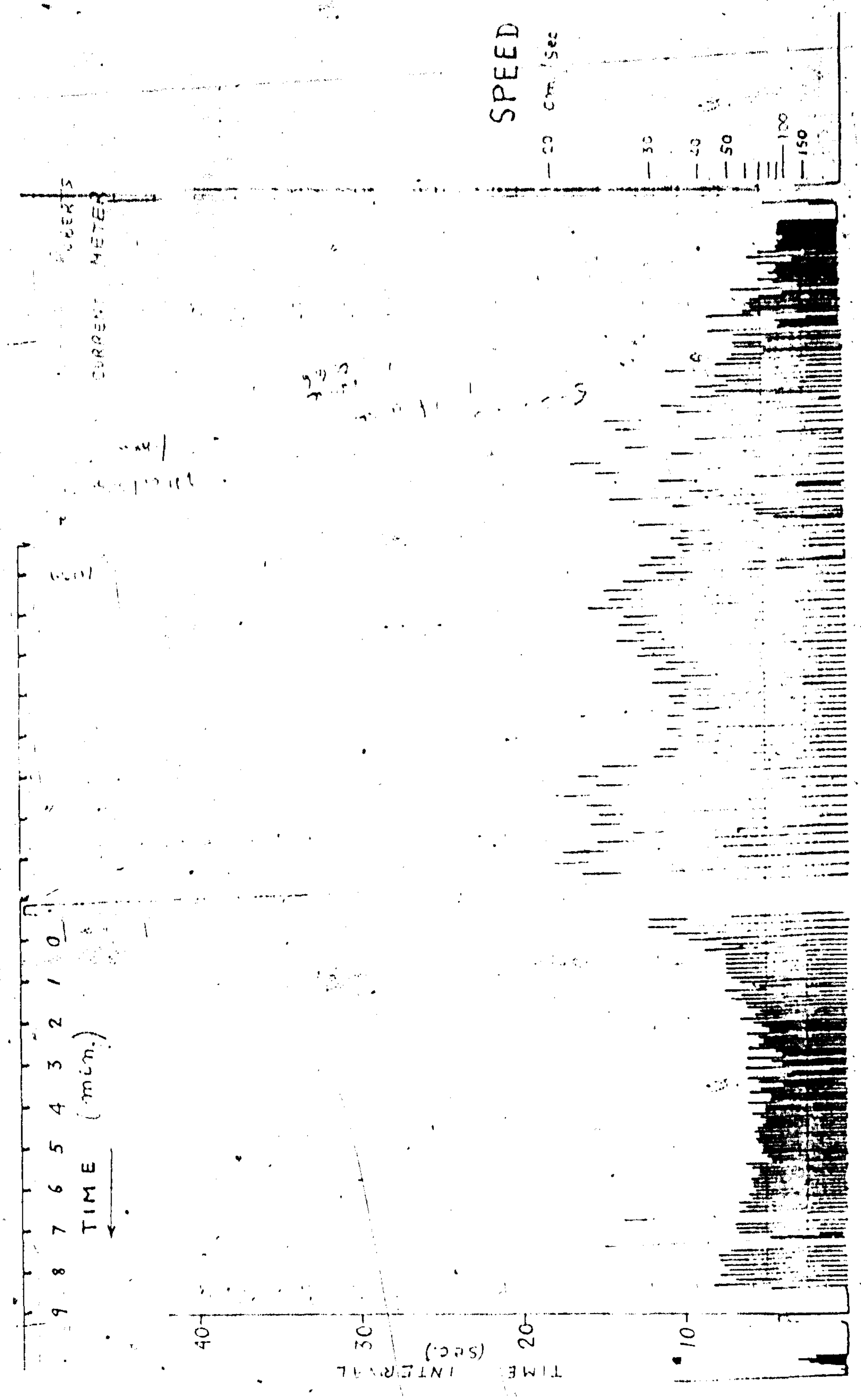
Sweep Generator:

In order to display the time interval between the velocity contact closures, a sweep generator was designed which commences its linear sweep after the velocity contact closure reopens. The sweep continues until the next velocity contact closure occurs, at which time the sweep is reset to zero and starts up again. Thus, for a constant velocity, the output is a saw-tooth wave of constant height, while a varying velocity will show up as a variation in the heights of the saw teeth (see Fig. 2).

The sweep generator is an operational integrator whose output is ideally $e_0 = \frac{1}{Rc} \int e_i \, dt$, where e_i is obtained from R_{10} and R_{11}. The time constant RC is selectable by means of the feedback capacitor C_5 and one of the resistors R_{12}, R_{13}, or R_{14}. The amplifier is a Philbrick, Type K2W, operational amplifier, with one of the inputs, pin 1, used for balancing the amplifier so that zero input results in zero sweep rate, and the other input, pin 2, used as the feedback mixing point.

The output at pin 6 is divided down by means of R_{19}, R_{20}, and R_{31}, so that it is compatible with the Leeds-Northrop Speedomax Chart Recorder which we were using. Since the maximum input to the L & N is 10 mv, the Limit Adjust is set so the voltage at TP 1 is 55 volts, when the amplifier is saturated. This prevents the application of an excessive signal to the L & N recorder and assures that the slight curvature in the upper portion of the saw-tooth falls just off scale. Three ranges of L & N pen sweep can be selected in the COARSE SWEEP SWITCH. A BALANCE position is also provided so that the BALANCE pot of the operational amplifier may be adjusted to provide zero output at the beginning of each sweep and no sweep drift due to amplifier offset. The FINE SWEEP pot determines e_i and thus also controls the sweep speed. The Table below shows the COARSE SWEEP SWITCH positions and associated parameters for our Roberts meter and system.

POSITION	PEN SWEEP TIME	CURRENT VELOCITY
1	Balance for no sweep	------
2	5 sec	350-100 cm/sec
3	20 sec	150-15 cm/sec
4	200 sec	30-5 cm/sec



Note that the inverse relationship between the contact closure, time intervals and the current velocity implies a non-linear velocity calibration on the L & N recorder, whereas the sweep is linear with respect to time.

Auxiliary Recording Equipment:

The above system handles only the velocity information of the ocean currents. For azimuth information, we use the polarized pulses alluded to earlier. By recording both the negative and the positive pulses, corresponding to velocity closures and azimuthal closures respectively, on one trace, it is possible to obtain the azimuthal orientation of the Roberts meter. These pulses are readily available across R_1 and can be recorded on a chart recorder such as a Brush or Sanborn.

Results

The chart record obtained is a visual presentation of the velocity. On a shipborne system, we observe undesirable movements of the ship superimposed on the current velocity.

Figure 2 shows long oscillations of the envelope of the time intervals due to ship travel, and a great irregularity in the saw-tooth trace due to the ship's roll and consequent tugging on the Roberts meter hanging over the side of the ship.

Further improvements on this prototype system are contemplated to permit direct recording of azimuth information, and a linear display of the velocity information.

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